

(3 Hours)

(80 Marks)

- N. B.:**
- (1) Question No. 1 is compulsory.
 - (2) Attempt any three questions from remaining five questions.
 - (3) Assume suitable data if necessary.

Q. 1 Answer any four questions (20)

- a) Write down about Macroscopic and Microscopic approach of Transport Phenomena.
- b) Derive Newton's law of viscosity.
- c) Explain diffusion.
- d) Explain temperature and pressure dependence of thermal conductivity.
- e) Explain the terms: forced and free convection.

Q. 2

- (a) Derive an expression for flow of Newtonian fluid over an inclined plate. (10)
- (b) An electric current of 200Amp is passed through stainless still wire having radius $r = 1.26$ mm and length $L = 91$ cm. The wire has a resistance of 0.126Ω . The outer surface temperature T_w is held at 422.1 K. The average thermal conductivity is $k = 22.5$ W/m. K. Calculate the centreline temperature. (10)

Q. 3

- (a) Derive an expression for conduction in composite wall. (10)
- (b) Estimate the viscosity of N_2 at 50°C and 854 atm, given $M = 28$ gm/gmole, $P_c = 33.5$ atm, and $T_c = 126.2$ K. (10)

Q. 4

- (a) Derive an expression for conduction in electrical heat source. (10)
- (b) Copper wire 10 mm diameter and 4.6 m long has a voltage drop of 0.6 volts, find the maximum temperature in the wire if the ambient air temperature is 298.15 K and the heat transfer coefficient h is 32.37 W/m² K
 - i. Lorenz constant for copper = 223×10^{-8} volt²/K²
 - ii. Thermal conductivity of copper at 298.15 K = 384.1 W/m K. (10)

Q. 5

- (a) Heavy oil is passed through a pipe of 5.08×10^{-2} m diameter. The pressure drop over the pipe is 68.958 kN/m^2 . The viscosity of oil is 200 Cp and density is 800 kg/m^3 . The length of the pipe is 3.048 m.
- i) Calculate the volumetric flow rate of oil in lit/min.
- ii) Calculate and plot momentum flux profile across the pipe. **(10)**
- (b) Derive an expression for Diffusion through a stagnant gas film. **(10)**

Q. 6

- (a) The distance between two plate is 0.5 cm and $\Delta v_x = 10 \text{ cm/sec}$, the fluid is ethyl alcohol at 273 K having a viscosity of 0.15 kg m/s, calculate the stress on each plate and the fluid velocity at 0.5 inch intervals from plate to plate. **(08)**
- (b) Write i) general momentum balance equation, ii) general procedure for setting up and solving viscous flow problems, and iii) boundary conditions. **(06)**
- (c) Explain the terms: convective and molecular transport of energy. **(06)**
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